DOCUMENT RESUME

ED 151 242 SO 010 497

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TITLE Energy and Sociology.
PUB DATE Sep 77
NOTE 21p.; Paper presented at Annual Meeting of the American Sociological Association (Chicago, Illinois, September 5-9, 1977)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Concept Formation; Conflict Resolution; Economic Factors; Economics; *Energy; *Futures (of Society); Intellectual Disciplines; Knowledge Level; Life Style; Pollution; Population Growth; Relationship; Research Needs; Scientific Research; *Social Problems; *Social Science Research; Social Values; *Sociology; Values

ABSTRACT

The realization that all scientific phenomena are manifestations of energy, rather than separate subjects of inquiry for chemists, physicists, or biologists, has encouraged scientists to explore gaps between the traditional fields of scientific inquiry. In light of this fact, it would seem that the flow of energy should be a major area of concern to social scientists, particularly sociologists. However, there is little evidence that sociologists are interested in influences which energy has had upon society. Aspects of this influence which sociologists might explore can be found by looking at the history of western civilization: expansion of trade and colonialization made possible by high-energy mechanisms such as the sailing ship; technological advances on life style; and passage of political power from landowners to traders and industrialists. Now that scientists and social scientists are questioning the survival of today's high energy society, sociologists are faced with new concerns and are responsible for providing propositions about a world in which surplus energy is in continuous decline. Possible topics for research by sociologists include energy conservation, the relationship of human values to material concerns, population trends, the pollutant effects of high energy, and proliferation of competing demands for energy. The conclusion is that sociological research will contribute the most to knowledge by investigating interactions between material and technological realities, such as the declining energy supply, and human values and attitudes. (Author/DB)

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ENERGY AND SOCIOLOGY

by

Fred W. Cottrell

When I first studied the hard sciences, more than half a century ago, the lines between physics, chemistry, and biology were pretty tightly drawn. The physicist confined himself to the basic ideas and within the boundaries that had been developed by the giant intellects of the past. Similarly, chemists concentrated on the study of molecular forms, treating atoms as being units with characteristics eternally assigned to them by the physicists. Biologists observed and classified the characteristics of living things, or their product, although the synthesis of molecules identical with those produced with the aid of life, but not themselves so created, threatened to break the boundary between biology and organic chemistry.

Today, of course, scientists readily move back and forth over the old boundaries as new instruments and new concepts render them less significant. There are biophysicists and biochemists and physical chemists who use new instruments to create new knowledge that defies many of the old laws and questions the axioms used to defend them. There are whole new fields of knowledge like electronics and nucleonics never dreamed of by the old masters. It would be futile for me to catalog these developments further. What I want to point out is that a major factor in the elimination of hard and fast boundaries between scientific fields was the elaboration of the idea that all of the phenomena being observed

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were manifestations of energy. With the wave theory it was possible to select for examination a segment of the spectrum extending from ultra short to extremely long waves. Scientists discovered that within certain ranges of wave shape, frequency, and amplitude, various types of patterns provided the subject matter for the separate disciplines. In many cases what had seemed to constitute impervious boundaries proved to be only the limited ability of the human to discover continuities. But once the idea was developed that the energy of the universe does provide continuity, scientists began to explore new means to bridge the gaps between fields of inquiry. Each new discovery provided new means to explore further the areas lying between traditional fields.

This development demonstrated that all science is limited by the fact that it is a product of the interaction between the human being and whatever else exists.

So the old eternal verities that barred thinkers from moving past the barriers to thought erected in the past by purveyors of THE TRUTH and crystallized in sacred cultures have, insofar as the hard sciences are concerned, been pretty well breached.

The results appear not only in the explanation offered by scientists, providing a rationale for science, but perhaps equally importantly in providing new means to use energy to achieve things impossible to men whose thinking was bound and fettered by the purveyors of the culturally sanctioned TRUTH.

Ability to overcome the limitations set on man by physical

and biological systems was always in part a result of changes in the way the flow of energy was being directed by man. We now know that widening these limits was achieved through feedback resulting from interaction between actions taken by the purposive organism and resultant responses from the pre-existing universe. Some changes, like the development of tools and the controlled use of fire, had long term effects in determining the kinds of plants and animals that survived. Those survivors then were always in part a product of the earlier choices made by their ancestors and in part a resultant of the dynamics of the natural (pre-existing) world. New biological forms were transmitted genetically to succeeding generations and new culture was passed on by cultural processes.

If we give to the set of factors that affect choice the term "value" there is no way that "values" and "material things" can be set apart as being independent one of another. They evolve together. At various times and places the impact that man has made seems to be miniscule, there is an enormous universe that seems to be untouched, not significantly modified, by the appearance of man. But even there scientists have been able to demonstrate that changes in the flow of energy are basic.

It would seem then that the flow of energy should become a major area of man's concern and resultant investigation. But there is little evidence that this is so, particularly in the social sciences. We need to look at the record to see how this came to be. And what are its consequences.

Science did not spring, fully developed, from the mind of Jove. But it did develop from individual effort by some very exceptional persons to understand what was going on around them. There is still no adequate explanation of the way the great seminal ideas were invented. But there is plenty of evidence to show the connections between new inventions, previously existing systems of thought, and the instruments provided the investigator by his culture. Of equal importance was the social reaction to these ideas once they were publicly delineated.

The defenders of ancient truth were wary of anything that might produce a rent in the seamless garment they had woven to cover their systems and which they zealously defended from destroyers of the Truth.

We can look at their efforts as being those of selfless devotion by convinced disciples. We can also see them as cynical exploiters of a system that provided wealth and power to the elites; land owners, military men, and church men. But all of them, no matter how motivated, would react in every way possible to destroy those who produced and promoted dangerous thoughts.

They were suspicious of early proponents of science, even those dealing with remote events, like astronomers. But they were even more adamant in stamping out thought that immediately and obviously threatened their own positions. Thinkers like Newton were not as ruthlessly extirpated or silenced as were those who attempted to provide a scientific explanation of human behavior.

So long as the flow of energy remained fairly constant, battles

between elites claiming the support of different ideologies simply transposed power from one area and one set of rulers to another. At time temporary energy gains from new plants or animals or more effective tools that permitted an increased flow in a system could upset the "normal" balance of power and influence that had prevailed. But so long as the overwhelming proportion of the energy available came from the sun by way of plants some kinds of inertial social systems reasserted themselves.

Newtonian physics with its emphasis upon the conservation of mass and energy did not provide an immediate threat to the defenders of things as they were. In fact, of course, it was used to reinforce the idea that natural laws, the thoughts of God, existed and were operative in the Christian world.

On the other hand, the expansion of trade made possible by using the surplus energy provided through the sailing ship did create a new basis for power. The ecological differential between places distant from one another could be exploited by using cheap transportation provided by the wind. And now those who had water-power could also make more effective use of it. They could, for example, produce cloth from fiber grown and manufactured with much less labor input than could people dependent only on manpower, and trade it with those who had to use their own soil on which to grow food. Wealth became less directly dependent upon the manpower that landowners had in the past controlled through producing food and monopolizing that control by the use military personnel dependent on them for that food.

However, it was the trader who came into control of the surplus energy derived from wind and waterpower. He, thus, became competitive with the old elites who continued to control energy derived from the sun by way of plants. But now he had to create an ideology that would make legitimate his exercise of power, And this forced a re-examination of the myths by which the old regime had been defended

A new basis for political power was created. God given rights were extended to "man" rather than to the monarch, and classical economics provided moral justification for the use of price in the market to allocate products to the consumer. Together with democratic theory, these supplied a means that did not use plants to increase the flow of energy.

Though, in fact, classical economics were being continuously reinforced by feedback from increased energy flow, the increased productivity was attributed not to energy, but to the ideas and the social arrangements that made it possible to use it.

Newtonian mechanics provided a framework within which tremendous technological advances were possible. But Newtonian Mechanics did not force any consideration of a finite limit to technology. The necessity for endless diversion of energy into new machines to direct massive increases in the use of energy from petroleum, gas, and coal justified postponement of the distribution of increased consumer goods. But little attention was paid to the fact that a larger and larger proportion of the energy being used came, not from the recurrent input from the sun, but from sources stored in the earth.

The Newtonians held that the amount of matter and energy in the

universe is constant. That law was interpreted to say that the amount of mass and energy on earth is constant. What was lost by one operation was gained by another.

Another set of laws, those of thermodynamics, held, however, that energy is constantly degrading from higher to lower forms. Every conversion of energy from one form to another results in the production of entropy, a form of energy so disorganized that it cannot be converted to a more organized form. Control over it is forever lost into the "heat sink", a place in the Universe not otherwise identified.

These laws were not given full credit by the Newtonians. They were regarded as being too anthropomorphic, too clearly an effort to solve human problems and so not "pure science". Besides, their recognition would put a cat among the pigeons that were being defended not only by physicists but by adherents to classical economics and all those who depended upon them to justify the operations of business men.

But it has been made obvious by evidence from a number of new scientific discoveries that the low entropy molecules upon which modern society is increasingly dependent are being converted to high entropy and lost to man on earth at a rate that cannot be long sustained, and this is a fact never acknowledged by those who hold that the economics of price assure that it will always guarantee physical efficiency.

But even among those who accepted the axioms of classical

thoughts, doubts about the infinite capacity of man to increase production and to raise his level of productivity were emerging. A few thinkers pointed out the fact that the new sources of energy could not be used to feed people. And that the growth of population pressed against the limited ability of the land to provide energy in the form of food. However, the propensity of man to reproduce up to those limits was turned to the support of the new science of economics. The "iron law of wages" demonstrated that the worker could not achieve more than subsistence, because if he had more income, more of his children would survive, reducing him and them again to starvation level. For him, there was no escape from conditions imposed by natural law.

No wonder that those who sought to improve the lot of man took refuge in the idea that while the realm of material things was governed by the dismal science, the spirit of man could conquer the material, and if he only would listen to the transcendant ideas coming from divine creation, all could be well.

A few thought to invent a science of sociology which would guide men to a utopia or at least make man's hope for the future more attainable. But this would mean that there was no inherent connection between the things amenable to scientific discovery and the product of the unfettered soul.

There was seldom any long-run, direct consequences of applying utopian ideas, since in most cases there was no significant increase in energy feedback that could reenforce them. No

increased flow of energy equipped the priest or prophet with the means to defeat an infidel who was able to direct a greater flow of energy to entice, corrupt, or coerce those who had only faith in the final truths of their belief with which to resist.

But the fight to preserve and enhance human values that were being sacrificed by those who did control increasing energy flow, in terms dictated by the market, demonstrated that human values were not all equally to be achieved by compliance with the edicts of those who were guided by the pursuit of profit. Proponents of these values turned to the state for redress.

Democratic theory holds that the ability legitimately to command specific performance, by physical coercion if necessary, lies with the people collectively. The popular will was, then, a force that could, in revolt against panderers in the market place, be used to protect and enhance whose values that were being sacrificed by adherence to economic doctrine.

There was a very strong movement to support "scientific socialism" which would rationalize the use of the "democratic state" to confine the rules of the market to areas where they did not impinge upon or destroy values not sanctioned by the law of supply and demand. Such "science" was too clearly and obviously value-directed to be acceptable to the pure scientists who wanted to establish laws <u>not</u> dependent upon human purpose, or limited to human capacity. They held that the only "real" science was value free. They blithely disregarded the fact that

there has had to be continuously repeated human choice to devote time and energy to the process of scientific discovery, in competition with other human choices.

That science is a value-free area of fact, unencumbered by the limitations of human perception and cognition, dominated prevailing thought. Anything such as thermodynamics so obviously contrived as an effort to solve human problems, was not entitled to respect and when confronted by classical scientific principles must always be downgraded.

Sociology was born into a world where "economics", the handmaiden of business, was accepted as a necessary product of natural law. There was supposed to be something inherent in man that would always cause him to choose material goods over any other. And the rule of price would most certainly guarantee that the hierarchy of values which put material things at the top would prevail.

Those who attempted to provide a scientific basis for the protection and advance of other human concerns were forced to accede to the dominance of those who directly controlled immense and increasing amounts of energy, with which they could provide a rationale for the idea that it was the "free market" which had produced all these goods.

That idea was challenged by the emergence of new industrial powers, Germany, Russia, and Japan who were able to increase the flow of energy and their productivity while disregarding many of

the axioms on which western economics were based. They used it more frequently for military and collective needs than for goods and services consumed by individuals.

Efforts to spread the western system through colonialism, which had depended heavily on increased energy flow, also failed when confronted with systems newly supplied with energy to be used to support other ideologies.

It was possible for the United States, with the use of the Marshall Plan, to revive the structure and ideology of Northwest Europe through massive injections of energy and its product. But Germany and Japan and the U.S.S.R., based on a different infra structure, used similar inputs to revivify systems in many respects altogether contradictory to classical thought.

Western failure to regain and redirect still other social systems demonstrate the bankruptcy of many sacrosanct ideas, once they were deprived of the energy previously flowing under their direction.

So long as there was a continuously expanding flow of energy it was possible to ascribe what was happening as being exclusively the product of ideology and the social structure which it explained and defended. But two recent developments have undermined the traditional rationale. One was, as noted above, the appearance of highly physically productive industrial systems based on a body of thought different from that held in Northwest Europe and North America.

The other, more important in my mind, was increasing evidence that the laws of thermodynamics are being demonstrated as being valid, and the results threaten the survival of high energy society. The evidence that the supply of fossil and mineral fuel is finite and nearing exhaustion is pretty conclusive. The probability that any other source of energy will replace it, producing surplus energy at rates comparable to those we now depend upon, is extremely speculative. In any case, the reorganization and relocation of human societies that would be required to serve it would, as shown by what is now going on, prove to be disastrous to many of the world's peoples. Social scientists will have to face up to those facts.

Classical economists based their case as being natural scientists on the fact that they dealt with material goods which must operate in accordance with the laws of nature. They developed the thesis that the price system operating through the law of supply and demand would always provide the most efficient use of natural forces.

In time, however, they came to identify economics with the use of the price system. Econometricists have to measure in money terms, but increasingly economists have had to deal with the fact that a great deal of the activity they are explaining consists of the delivery of services, not the production of material goods. The connection between the amount of human energy involved in the delivery of such service and the price put upon it has become so tenuous that any effort to justify income in terms of mechanical

"work" done by the recipient is absurd. All that the economist can do is to attempt to show that the price of human cooperation includes its cost in terms of time. But the time cost of a service is as much or more a function of the amount and kinds of energy involved in its delivery as of any other factor.

In the classical economics, certain productive factors have been considered to be free goods because the supply cannot be controlled and those who use them cannot be charged for that use. Energy, along with air and water, was put in that category. They were the "free gift of nature."

Since they were not costs that the producer who used them had to pay, they were not among the things to be economized. The primary effort of business men became that of substituting more and more costless surplus energy for costly factors of production. But given the fact that there is a finite amount of low entropy matter available, this was disastrous. Under the price and profit calculus, business men came to act like one who has received a legacy upon which he draws at will for the benefit of a firm but does not count his withdrawals in making his cost benefit analysis of that firm.

The consequence of this performance has taken two primary forms. First, the pollution of air and water that has resulted from this vast consumption of energy has resulted in widespread creation of political "interference" with the proposed actions of those people who, acting on the price-profit nexus, have created and continue to create a less habitable world. Secondly, those who feel an obligation

to preserve for posterity energy that is now being wastefully used are calling upon government to protect them and their successors against the wasters. Many economists have resisted these moves on the ground that they interfere with economic laws which are more beneficial to man than those based on concern for other than "economic" return. But except for a very few who know what would happen if "all other things were equal" they themselves support the use of the state to assist business through taxation, fiscal and monetary policy, and the provision of services that are necessary if business is to operate but beyond its capacity to supply, like policing, defending the country, supplying water, disposing of waste, providing transportation and communication, and providing most of the means to maintain health and education.

All of these services contribute to the creation of goods sought by people. The values they serve are often indistinguishable from those satisfied by the private sector. When satisfaction is achieved through use of means sanctioned by the market it is called production. But there is no economic "benefit" listed for the same result when it is achieved by the state, the community, or the family. They do not constitute part of the gross national product. Their costs have to be met by "transfer payments" from the only "real" product, that measured in the market. As more and more goods and services are produced in ways not sanctioned by price and profit this fiction becomes less and less tenable. On the other hand, business is more and more forced to include in its operations consideration of values only

remotely related to physical production. So the economist must deal not only with "material values" but a wide range of those whose origin has been left to be explained by others who, in turn, are not considered to be capable of understanding or explaining the relationship between the material world and that of values and attitudes.

The traditional academic division of fields of thought relating to social man are rapidly being eroded by the results of high energy use, as were the dividing lines between the hard sciences. Students in such disciplines as political science, geography, anthropology, psychology, and sociology now have both the opportunity and the necessity to examine man's relation to the material world. They are no longer bound by the economists' claim to infallible knowledge.

But all social scientists are still limited by the kinds of knowledge that they have to rely upon. All science depends upon validation through the observation of events. And the events they have to draw upon--insofar as they relate to the consequences of introducing great quantities of energy from sources other than plants--have taken place (with only very limited exception) in the last four hundred years during which the "Expansion of Europe" occurred. Trends observed in the West during that time have been generally assumed to be perpetual or cyclically moving in the same direction over the whole world.

What we now need to provide, if our findings are to be useful to people in the future, are propositions about a world in which surplus energy--energy available over and above that expended in

making it available--is in continuous decline. This is, on the basis of evidence now available, the overwhelmingly probable course of events.

Now apart from the regularities observed among the low energy societies, we know very little about the sociology of stable social systems. We know even less about those where the energy available to them is declining. The whole doctrine of "progress" and inevitable success of rising expectations were inculcated by men who knew little and cared less about the laws of thermodynamics and the geology of fuel sources. But these factors can no longer be left out of account. So, at the moment we can only speculate about the way contracting systems will perform, and how value hierarchies and social structures within them will be affected.

But, as an example, I will discuss briefly the way the "population explosion" has been explained in recent literature and how the inclusion of energy may alter predictions about it. Rapid increases have been attributed to the fall in the death rate which accompanied the spread and application of health sciences. Little attention was given to the equally astounding increase in the supply of food which made the increase possible. For the most part it depended upon increased inputs from fossil fuel and hydro power, delivered in the form of cultivation, fertilizer, and transportation. Many times increases in population were only possible because food was imported from other regions, with effects we will look at in a moment.

Efforts to contain this dangerous growth in numbers of people have been concentrated on reducing the birth rate. This was an

effort to change the primacy of various human values. But it has become more and more apparent that it has been successful primarily where increased energy flow has provided new rewards for those who limit their offspring. This will be increasingly difficult in a contracting system.

To return to the matter of food increase. It has come from the few places in the world where great food surpluses are possible. It is people in these areas who will decide whether to use increasing amounts of energy to support larger and larger populations in regions where the population is now barely able to survive or instead to devote that energy to the satisfaction of their other values. If they are to deliver food sufficient to feed everybody who has been conceived, anywhere in the world, they must share a value hierarchy that demands that this be their first concern. There is little evidence that such a value hierarchy iniversally exists or is being created. Two kinds of evidence are involved in discovering what the outcome is likely to be. One relates to the way values emerge in a society. The other to the specific kinds of values that are created in high energy systems.

Only a short while ago it was widely held that through modern means of communication there would emerge a civilization common to all men. There would be One World. However, the actual course that has been taken is the appearance of a great proliferation of parochial systems devoted to the maintenance of value hierarchies that give top priority to the survival and enhancement of national, tribal, and even familial systems.

Values are initially inculcated in local areas, through primary groups. Such groups place stress on locally acceptable values and make them supreme. It is obvious that only very extensive and energy-costly efforts will be able to overturn the hierarchies continuously recreated by these natural processes.

The other great set of factors that reduce the probability that individual survival will become the supreme value everywhere is found in the industrializing process. To entice low energy people to abandon their old way of life, those seeking to industrialize have provided them with increased wealth, produced with surplus energy. Industrialized workers continue to demand more things, which requires more energy to provide the machines used in production as well as the consumption goods themselves. But, on the other hand, the production of food for more and more people has required that more and more energy be used to supply fuel for men who are very costly converters using expensive fuel. Producers in areas that have been industrialized, then, must make choices between either using more energy to produce food or other desired things. They must also decide whether to exchange that food for the very limited product of hungry people or with wealthier people who can give in exchange for food the products of high energy technology. There is plenty of evidence to show what that choice will be. We'll cite only one example.

People with the means to do so demand more meat and other animal products. Along with other industrial people, the Japanese are willing and able to pay a high price for protein. As a result,

American farmers produce, among other things, a great amount of soybeans, a rich source of protein. Seventy percent of the beans imported into Japan from the U.S.A. are used to feed animals. This means that more than three-fourths of the calories that could have been produced if the beans were eaten directly are lost in converting them to meat. Yet there are large areas in nearby ASIA where malnutrition is endemic. The choices made in Japan are similar in this respect to those being made in much of the high energy world.

To satisfy their new psychological demands, industrialized people have created social structures that permit them to claim large portions of the newly created flow of goods and services. Unions are concerned to see that workers get their "fair share", corporations create monopolistic systems, and a great part of "the public" use various kinds of means, including political organizations that induce government to divert energy to the supply of their needs. All of these movements take place in limited areas of the earth. They culminate in many cases in nationalism which often becomes the supreme value--a religion.

So, social scientists will have to look at this proliferation of competing values. Superficially we have examined the prospect that industrial people will sacrifice their other values in order to feed all the babies that are born. If the answer is in the negative, then the probable future size of the world's population is not what many demographers have predicted. Similarly, the

increased scarcity of energy is likely to lead to a great relocation of population moving from areas where heating costs are high to other areas. And many other ecological factors will work differently as energy is reevaluated, altering price measured costs as they now exist. The number of such changes to be made is legion, and the size of some of them is staggering. In short, the impact of changing energy flow as it affects and is affected by human choice will have to be determined by analysis that covers the whole range of science, be it physical, biological, or social.

The task may be greater than it is possible for humans to perform. The outcome may instead be determined by the resolution of conflict among men, institutions, and technologies, with no scientifically discernible conclusion. But it is becoming obvious that solutions based upon the separation of values from other human attributes, and from the physical and biological forms through which energy flows, is less and less effective in understanding man and his future.

What is left for us to do here in this forum is to speculate upon the basis of the little we know as to what the future holds for sociologists.